

Social Capital, Organizational Learning Capability, and Technological Knowledge Transfer

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This study uses inter-organizational networks to focus on firm opportunities to establish the level of social capital required to efficiently utilize network resources among certain collaborative research projects. This study reached the following conclusions: (1) establishment of social capital does little to improve the technological knowledge transfer; (2) organizational learning is the necessary condition for improving technological knowledge transfer performance. Only certain social capital factors combined with certain organizational learning capabilities can enhance performance.

KeyWords: Social Capital, Organizational Learning, Technological Knowledge Transfer

Given a fiercely competitive industrial environment, the effective external technological transformation of firms has become a key strategy for firms in maintaining their competitive advantage. The collaborative relationships involved in achieving technological knowledge transfer that appear abundant in small and medium-sized companies have become a key industrial development strategy in Taiwan. The production technologies used by small and medium-sized companies are improving and Taiwan is now considered a strong international competitor. To ensure the competitiveness and further development of Taiwan's small and medium-sized companies, management scholars now see the study of firm collaboration in technological research as a significant area (Fang, 1999).

Although technological knowledge transfer has been extensively studied, the lack of any clear illustration of practical solutions in these works requires more in-depth theoretical studies. The reasons for this study are as follows: (1) since it is valuable, unique technological knowledge is generally tacit and difficult to transfer. Therefore, the creation of a stronger competitive advantage through social capital and emphasizing organizational relationship leverage would be the main objective of any research on technological knowledge transfer (Gulati, 1999; Nahapiet & Ghoshal, 1998; Tsai, 2001; Yli-Renko et al., 2001); (2) previous joint production and research was restricted to being among firms and research institutions. However, the relationship between firms and research institutions is known as "dyadic" interaction (Fang, 1999). Previous studies have rarely mentioned various firms working together on the same technology project, and the role of firms in the entire technology project.

This study closely examines all of the organizations belonging to a network of firms engaged in technology R&D programs (TRDPs). The external capability (social capital or organizational relationship leverage) and internal capability (organizational learning) of the firms are used to discuss the technological knowledge transfer performance. More specifically, this study examines (1) The social capital of firms involved in joint technology projects, and the influence of this social capital on the technological knowledge transfer performance (2) the abilities of firms to conduct internal organizational learning and their ability to influence technological knowledge transfer performance (3) Whether social capital (external capability) and organizational learning (internal capability) have a mutually complementary relationship.

Many scholars mention that the creation of a stronger competitive advantage through social capital and emphasizing organizational relationship leverage would be the main objective of any research on technological knowledge transfer (Gulati, 1999; Nahapiet & Ghoshal, 1998; Tsai, 2001; Yli-Renko, Autio & Tontti, 2002). In addition, according to Gulati (1998), organizational learning capability must be explored in relation to firm network. Previous studies specifically aimed to obtain and apply required technologies via external networks. However, firms are expected to maintain a certain level of internal abilities (e.g., assimilation and organizational learning) to ensure the effective application of externally sourced technology.

Theoretical Framework

The theoretical foundation for this study is social capital and organizational learning capability. Since this study
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focuses on technological knowledge transfer among firms, the embedded relationships of network and how to integrate organization internal/external knowledge are two major concepts. Therefore, social capital of the alliance firms and organizational learning capability are discussed.

Social Capital of the Alliance Firms

The definition of social capital in this study is focus on a network perspective rather than only using the dyadic outlook (Gulati, 1998; Koka & Prescott, 2002). In addition, the essence of social capital in this study is that comprises context-specific relationships, including relational embeddedness, structural embeddedness and cognitive context (Adler & Kwon, 2002; Nahapiet & Ghoshal, 1998).

Structural dimension – core and network connections: The structural dimension of social capital describes the situations created by the focused firms that best facilitate organizational relationships (Gulati, 1999; Kale et al., 2000; Nahapiet & Ghoshal, 1998). Specifically, if the alliance firms involved in a TRDP can establish a good position in the relational structure of the network, they can obtain diverse and richer information (Koka & Prescott, 2002), enabling more rapid knowledge circulation, efficient organizational learning and improved technological knowledge transfer performance (Nahapiet & Ghoshal, 1998; Powell et al., 1996). Thus, Hypothesis 1 of this study is that the firm participating in a TRDP will have a more efficient technological knowledge transfer performance when it occupies the core position, or has numerous network connections with members in the same TRDP.

Relational dimension - relation intensity and relation quality: The relational dimension of social capital is the social interaction quality (Yli-Renko et al., 2001) among the members of a collaborative research network. Relational embeddedness shapes the cooperative atmosphere among the network members. Under an atmosphere of mutual benefit and community identity, network members are willing to exchange and share knowledge to improve the quality and quantity of information provided by individual firms (Koka & Prescott, 2002), and ultimately improve the technological knowledge transfer. Consequently, the Hypothesis 2 is that Firms participating in a TRDP will achieve more efficient technological knowledge transfer when they have close interaction and mutual trust with other firms.

Cognition dimension – cognitive context and common norms: The cognition dimension of social capital comprises the mutual identification, norm, faith, hope, and experience of the organization members (Adler & Kwon, 2002; Nahapiet & Ghoshal, 1998). Cognitive context in this study is defined as when members of a collaborative research network adhere to the common values and goals of the group. They show willingness to cooperate and achieve mutual benefits. If certain members of the network organization can establish some solidarity, it becomes possible for them to minimize communication barriers and opportunism given the same behavioral hypothesis, norm and shared context. Furthermore, members will have a stronger motivation and more opportunities to share knowledge resources (Adler & Kwon, 2002), thus achieving benefits in obtaining knowledge and improving the technological knowledge transfer of the focused firms. This study establishes Hypothesis 3: firms involved in a TRDP will have better technological knowledge transfer performance when they share a common cognition context and norm.

Organizational Learning Capability

According to Popper & Lipshitz (1998), the final objective of organizational learning is to apply the new knowledge as part of the organizational regulations, and systematize it so that it serves as the criterion for member operations and behavior. High organizational learning capability, besides helping an organization to modify existing knowledge, also helps an organization to integrate its existing knowledge with external knowledge, and simultaneously spreads and facilitates the creation and storage of the organizational database (Inkpen & Dinur, 1998). This study has concluded that organizational learning capability is reflected in: (1) learning intentions (Hamel, 1991; Inkpen & Dinur, 1998); (2) absorption capability (Zahra & George, 2002); (3) knowledge integration capability (Okhusen & Eisenhardt, 2002; Teece, Pisano & Shuen, 1997).

Learning intention: Organization learning intention means that firms participating in a TRDP consider problem solving and task implementation to be a learning opportunity right from the very beginning (Hamel, 1991). When a firm is determined to learn, a better learning environment will be established in collaborative research. The organization will enhance its skill in combining and applying the acquired knowledge, thus improving firm technological knowledge transfer performance. Thus Hypothesis 4 is: during collaboration, the greater the learning intention of firms involved in a TRDP, the more efficient the technological knowledge transfer will be.

Absorption capability: Absorption capability describes how firms participating in TRDPs understand the value of new knowledge, obtain new information, and assimilate this information to facilitate the creation and storage of organizational knowledge (Szulanski, 1996). Normally, if a firm invests in a certain technology, its absorption capability (Helfat, 1997) will assist in distinguishing, clarifying and simulating the core technology and knowledge of its research partners. Likewise such investment will determine how this firm applies, integrates and even

maximizes its core skills (Zahra & George, 2002). Thus, Hypothesis 5 of this study is: the higher absorption capability of firms in a TRDP possessed, the better the technological knowledge transfer performance.

Knowledge Integration Capability: Organizational knowledge as the integration of information differs from simply focusing on knowledge analysis at specific stages. Recently, research by certain dynamic capability scholars (Blyler & Coff, 2003; Teece et al., 1997) has stressed that knowledge integration capability aids organizations in enhancing their knowledge creation performance. For this study the objective of knowledge integration is to allow knowledge to be utilized in organizations with sufficient integrality and sufficiency to enhance the technological knowledge transfer of firms participating in TRDPs (Popper & Lipshitz, 1998). Therefore, this study develops Hypothesis 6: Firms participating in a TRDP have high technological knowledge transfer performance when they have high knowledge integration capability. In addition, Hypothesis 7: A complementary effect exists between the organizational learning capability and social capital for firms participating in TRDP in relation to technology transformation performance.

Methodology

Sample

The sampling frame comprises organizations that participated in the TRDPs initiated by the Industrial Technology Research Institute (ITRI) from 1986 to 1991. The data are drawn from previous statistical information obtained from the Department of Industrial Technology under the Ministry of Economic Affairs. The final survey design was revised accordingly after a pilot test involving three project managers from organizations engaged in the TRDPs. The sample was drawn from the firms that participated in the TRDPs from 1986 to 1991. Totally, 650 questionnaires were distributed, 450 were posted while 200 were sent via e-mail. The sum of all significant participants in technology projects constitutes the population. Totally, 110 responses were obtained for a response rate of 17%.

Instrument and Measurement

The three main research constructs in this study are social capital, organizational learning capability and technological knowledge transfer performance. This study examines a total of 13 variables. A seven-point Likert scale was used to establish the reactions of the respondents for each and every variable, where "1" denotes absolute disagreement and "7" indicates absolute agreement.

The social capital in this research describes the network resource capabilities obtained by the firm through specific network embeddedness in the TRDPs (Gulati, 1998; McEvily & Zaheer, 1999). This study employed the viewpoints of Nahapiet and Ghoshal (1998) and Yli-Renko et al. (2001) in adopting the six variables, namely: structural dimension (core/network connections), relational dimension (relation intensity/relation quality), and cognition dimension (shared value/common norms) as overall indicators of the social capital construct. The three organizational learning capability variables, namely learning intention, absorption capability, and knowledge integration capability were adapted from Hamel (1991) and Inkpen & Dinur (1998). The variable used to measure technological knowledge transfer performance in this research comprises the possible benefits of technological knowledge transfer, including cost advantage, market advantage, technological advantage, and new product development advantage.

This research emphasizes how firms participating in TRDPs can fully exploit social capital to upgrade their technological knowledge transfer. The duration of firm participation in collaborative research is believed to directly influence the social capital gathered by the firms (Adler & Kwon, 2002). In addition, firm size can also seriously influence the performance quality of technological knowledge transfer. Therefore, the control variables in this study are the duration (expressed in time or hours) and size of firm participation in the TRDPs.

Validity and Reliability

Since variable assessment and processing is based on the arguments in the related literature, and since management personnel of firms engaged in TRDPs were selected as survey respondents, thus a positive level of validity is achieved for the data samples obtained from the survey. In demonstrating the reliability of the data, the item analysis method was used to eliminate data samples that showed no significant discrepancies. The reliability of the variables range from .75 to .87. Principal component factor analysis was used to compute the Crobach α value of each variable. Since the α value exceeds 0.75, it confirms the reliability of the samples used in this study. Notably, two factors were extracted after applying the principal component factor analysis to the technological knowledge transfer performance. The accumulated variation value obtained was 82.1%. Based on the factor loading, two variables of technological knowledge transfer performance were re-named market benefits (TT_1) and technology benefits (TT_2).

Data Analysis and Results

This study aims to test and verify whether the social capital (SC) and organizational learning (OL) of firms participating in TRDPs assists in improving the technological knowledge transfer performance (TT). Hypothesis 7 (H_7) establishes whether an interactive effect (namely, complementation) exists between SC and OL. This study used the multi-regression analysis method to determine the dependent variables in the regression model, namely: market benefits (TT_1) and technology benefits (TT_2). Tables 1 and 2 show the results of the regression analysis.

Table 1. *Regression Analysis of Technological Knowledge Transfer Performance - Market Benefit (TT_1)*

Model	1	2	3	4	5	6	7	8	9
Duration (control variable)	.20*	.21*	.23*	.25*	.22*	.19*	.24*	.20*	.26*
Size (control variable)	.09	.11	.08	.15	.13	.06	.10	.08	.10
Core (SC_1)	.16	.09	.18	.15	.08	.11	.02	.12	
Network connection (SC_2)	.22*	.24*	.28*	.23*	.24*	.25*	.30*	.22*	
Relation intensity (SC_3)	.14	.17	.16	.16	.18	.13	.12	.18	
Relation quality (SC_4)	.12	.08	.14	.06	.11	.10	.13	.17	
Share value (SC_5)	.07	.15	.10	.02	.12	.16	.05	.14	
Common norms (SC_6)	.11	.04	.17	.15	.10	.14	.08	.10	
Learning intention (OL_1)	.30**	.32**	.35**	.28**	.26**	.54***	.40**	.38**	
Absorption Cap. (OL_2)	.36**	.52**	.48***	.40**	.36**	.50**	.45**	.22*	
Integration Cap. (OL_3)	.25*	.21*	.19*	.20*	.23*	.18*	.30**	.26*	
$SC_1 \times OL_1$.57**						
$SC_1 \times OL_2$.66***					
$SC_2 \times OL_1$.42***				
$SC_2 \times OL_2$.48**			
$SC_4 \times OL_1$.64***		
$SC_4 \times OL_2$.58**	
$SC_6 \times OL_2$.52**
F value	11.23	10.34	14.08	13.44	15.36	14.26	13.94	14.48	15.02
R ²	.21	.42	.50	.48	.56	.51	.49	.53	.54
ΔF value				3.74***	3.10***	5.02***	3.92***	3.60***	4.14***
									4.68***

Note: * = P < 0.1, ** = P < 0.05, *** = P < 0.01

The following are the reasons this research opted to incorporate cross independent variables into the regression model with six social capital and three organizational learning variables, for a total of 18 interactive factors: (1) Each pair of the 18 cross items is highly correlated (the pair with the least correlation still has a significant coefficient value of 0.45), and, thus, a deviation is expected to occur in the multi-collinearity since these factors appear in the same regression model; (2) The valid samples gathered in this study appear insufficient ($n=110$), and too many independent variables can produce some deviation errors in the regression results (Lee, et al., 2001). Additionally, Table 1 shows that the cross factors were prevented from reaching a significant level given increasing F value for the entire Regression Model.

Initially, given the results associated with the control variables in this research, the model one in Table 2 exhibits a positive relationship in the research sample containing firms participating in TRDPs and the duration of firms participating in TRDPs in terms of technological knowledge transfer performance. That is, the longer the collaborative researches take the deeper and more intense the organizational learning becomes, thus improving the technological knowledge transfer performance of the organization. The results of Model 2 in Table 1 demonstrate that among the six variables representing social capital, only the number of network nodes (SC_2) significantly influences market benefit, while the remaining social capital variables (SC_1, SC_3-SC_6) failed to reach significance. It can be said that Hypothesis 1 of this research is partially supported but not Hypothesis 2 and Hypothesis 3. The reason for this phenomenon may be: (1) The TRDPs in Taiwan most of time last for approximately 3-5 years. The time frame is a relatively short period, and thus it may be difficult for individual firms to accumulate sufficient social capital (Adler & Kwon, 2002); (2) Till the social capital becomes positive, even given market, industrial or other competition among the affiliates, the information exchange remains predominantly fragmentary and lacking in depth. This information exchange does not provide further insight into individual firms regarding market competition. On the other hand, organizational learning factors (OL_1-OL_2) reached a significant level, and thus

Hypotheses 4-6 (H_4-H_6) were supported. However, the “external abilities” of the firms, which are represented by the establishment of social capital, display very little influence in upgrading firm market benefits.

Table 2. *Regression Analysis of Technological Knowledge Transfer Performance - Technology Benefit (TT_2)*

Model	1	2	3	4	5	6	7	8	9	10
Duration (control variable)	.33**	.26*	.20*	.27*	.18*	.23*	.19*	.30**	.35**	.22*
Size (control variable)	.20*	.15	.10	.22*	.11	.15	.13	.09	.17	.14
Core (SC_1)		.36**	.28*	.06*	.15*	.23**	.30**	.27*	.20*	.18*
Network connection (SC_2)	.08		.16	.12	.06	.04	.14	.17	.15	.09
Relation intensity (SC_3)	.12		.13	.16	.14	.09	.16	.15	.13	.12
Relation quality (SC_4)	.24*		.26**	.28*	.29**	.25*	.22*	.37**	.19*	.31**
Share value (SC_5)	.16		.06	.10	.08	.14	.05	.11	.07	.16
Common norms (SC_6)	.26*		.22*	.19*	.18*	.20*	.21*	.19*	.24*	.20*
Learning intention (OL_1)	.32***		.40**	.48***	.35**	.47***	.40**	.42**	.38**	.46**
Absorption Cap. (OL_2)	.41**		.54***	.50***	.30**	.33**	.28**	.30**	.45**	.52***
Integration Cap. (OL_3)	.40*		.23*	.28*	.14*	.24*	.19*	.20*	.19*	.25*
$SC_2 \times OL_1$.67***							
$SC_2 \times OL_2$.52***						
$SC_3 \times OL_1$.62***					
$SC_3 \times OL_2$.44**				
$SC_4 \times OL_1$.48***			
$SC_4 \times OL_2$.44**		
$SC_5 \times OL_1$.46**	
$SC_5 \times OL_2$.58***
F value	12.13	11.02	14.47	15.04	16.02	14.64	15.28	14.26	14.38	15.40
R ²	.37	.44	.48	.53	.60	.51	.56	.46	.47	.57
□F value			3.45***	4.02***	5.00***	3.62***	4.26***	3.24***	3.36***	4.38***

Note* = P0.1** = P0.05*** = P0.01

Regarding the technology benefits (TT_2) of firms participating in TRDPs, the regression analysis results of Model 1, listed in Table 2, demonstrated that the control variables used (namely, duration and size) significantly influenced the market benefits and technological knowledge transfer performance. Table 2 showed that the regression coefficient between TT_2 and organizational learning factors (OL_1-OL_3) are reached a significant level, therefore, Hypotheses 4-6 (H_4-H_6) are supported. Regarding the influence of social capital (SC) on technology benefits (TT_2), the core position of the firm in the TRDP network and the better relation quality in the network, and the mutual trust among the affiliates all significantly affected technology benefits. Nevertheless, the remainder of the regression coefficient of the social capital variables failed to reach significance. Thus, Hypotheses 1-3 (H_1-H_3) in this study are partially supported. The above-mentioned social capital variables, namely numbers of network nodes (SC_2), relation intensity (SC_3), and shared values (SC_5), failed to significantly affect the technology benefits (TT_2) of individual firms. Possible reasons may resemble the previous argument regarding market benefits. Sample firms of this study, in which participating TRDPs with short duration, provides insufficient time to lay down the foundation for mutual trust and to establish the appropriate network nodes. Consequently, the social capital accumulated by firms would prove insufficient to improve the quality and quantity of technical information exchange among the affiliates participating in the technology project. To conclude, of the hypotheses regarding the effects of social capital and organizational learning on technological knowledge transfer performance, only H_4-H_6 (organizational learning) are supported, while the social capital variables (H_1-H_3) are partially supported.

Conclusions and Contributions

The findings of this empirical study include: (1) Among the social capital variables, only the core network significantly influenced market benefits, while number of network nodes, relation quality, and common norms significantly enhanced the benefits of the technological knowledge transfer. Meanwhile, the rest of the social capital factors exerted no effects or benefits on the technological knowledge transfer. (2) Organizational learning (learning intention, absorption and knowledge integration capability) positively influences the improvement of technological knowledge transfer performance. (3) Under certain conditions, organizational learning and social capital exerted

complementary effects on technological knowledge transfer performance. For example, certain social capital factors, such as the core position of the network and better relation quality, significantly contribute to the market benefits of firm technological knowledge transfer if they are combined with certain organizational learning factors such as learning intent and absorption capability. Meanwhile, when numerous network nodes, high relation intensity and more unified shared values are combined with high learning intention and absorption rate, profitable effects are generated on the technology benefits.

Regarding the aims of this study, previous studies did not use the network standpoint together with organizational learning concepts to discuss the cooperation between Production and Research. Nonetheless, in the “competition and cooperation” pattern that exists within industrial competition, building up firm internal strengths and combining these strengths with external organizational relationship leverage is necessary for maintaining firm competitive advantage. Therefore, the topics discussed in this research not only conform to current trends, but also pave the way for more in-depth deliberations regarding the theoretical groundwork of production-research cooperation. Compared to the predominantly “dyadic” viewpoints used in previous studies (interaction is restricted to being among firms or between the firm and research institution), this study adopted the “network” standpoint for discussing the collaborative research management and clarified the following: (1) the role of the firm in the entire collaborative research network (structural dimension), and (2) social capital and the effects attributed to the “firm-ITRI” and “firm-firm”.

This study has both theoretical and practical importance. It is theoretically important in that the results of this research will provide especially valuable information for HRD professionals to understand the content and relationship between social capital, organizational learning capability and technological knowledge transfer in the Taiwan context. It confirms a theoretical position that organization should commit to organizational learning and social capital in order to enlarge the degree of technological knowledge transfer. Regarding the present research topics, the empirical results show that besides the desire of the organization firm improve its technological knowledge transfer, interaction between organizational learning capability and social capital are two necessary complementary factors.

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